

XXIII.—*The Polar Origin of Life considered in its bearing on the Distribution and Migration of Birds.*—Part I. By H. B. TRISTRAM, D.D., F.R.S.

THE solution of the various perplexing problems connected with the classification, distribution, and migration of birds may, as it appears to me, be assisted in no slight degree if we view these problems in the light thrown on them by the theory of the Polar origin of all life. In fact, I can find no problem connected with bird-life which is not more easily explained by this theory than by any other. I hope, therefore, that the readers of 'The Ibis' will pardon me if I occupy a few pages with a summary of the general question by way of preface.

However successfully we may classify the distribution of life and sketch the limits of the various regions and areas, yet we cannot find in the most accurate and careful geographical arrangements any clue to the origin or the distribution of bird-life. How is it that while in some families, such as the Thrushes, we find generic identity through the whole world, whole families, and even orders, are confined to one area and absent from others under identical climatic conditions? There is certainly nothing in the *present* distribution of bird-life to explain these phenomena. With so many similarities among so many differences, we cannot assume many original centres of life. We must go back to the original locality of life. It will be granted that life can only have commenced in those parts of the world which were first prepared to maintain it, and that the earth has been a gradually cooling mass, of which those parts which cooled first would be the fittest to maintain life. Now those parts which received the least heat from the sun, and which radiated heat most rapidly into space, must have been the first to cool. These are the Arctic and Antarctic zones. These zones were at one time too hot, and are now too cold for the life which now inhabits the warmer zones, and they must have passed slowly through all the degrees of temperature fitted for every form of life which exists or has existed on the earth. I confine myself to the North Polar zone exclusively; for while, as I shall

presently endeavour to show, the stream of bird-life has been continuous from the North Pole to the most southern regions, there is no evidence of life having been diffused from the South Pole. There are only two forms of bird-life exclusively circumpolar in the southern regions which have not clearly a northern origin, viz. the Sheath-bills and the Penguins. The former are too closely allied in structure to the Oyster-catchers to enable us to found any argument on them; the latter may be the solitary survivors of a South-Polar avifauna.

But the physical conditions of the opposite zones are very different. Sir J. Hooker has remarked that he can find no plants in the Antarctic regions which do not bear indisputable traces of a northern origin, except, possibly, a few lichens and seaweeds. The results of the soundings of our scientific expeditions show that almost the deepest seabottoms on the face of the earth girdle the Antarctic continent, and Mr. Murray has pointed out that we have every reason to believe that the deep ocean-depressions have existed since the earliest solidification of the earth's crust. The dredging of this ocean has produced no trace of sedimentary rocks, but only the detritus of primitive or azoic rocks. Now no spaces present greater obstacles to the transit of life than deep oceans. We may infer, then, that, if bird-life did exist on that primitive continent (and it very probably was created there, as well as at the north), when the temperature gradually sank, mammals and birds could have had no escape from the increasing cold, and, having no near lands in which to take refuge, they, with the exception of the Penguin family, ultimately perished.

On one, and only one, hypothesis can the origin of life at the Poles be controverted, and that is that the axis of the earth may have changed, so that the Poles may formerly have been at very different points of the earth's surface. But our greatest mathematicians have examined this theory—first started to explain the existence of the Miocene flora in the Arctic zone—and Sir W. Thompson, Dr. Haughton, Prof. G. Darwin, and others agree that there is no evidence of such

change, certainly not during geological history ; while at the same time they admit the *possibility* of stupendous land-changes having taken place in the earlier age of the planet, of which we can find no existing evidence.

It is unnecessary to enter on the geologic record of the sequence of the Arctic flora from the Silurian corals to the later Miocene ; this has been admirably summarized by Lt.-Col. Feilden in his Presidential Address to the Norfolk Naturalists' Society in 1886. Ornithology cannot afford the like geological evidence with botany, for we know how comparatively rare are ornithic relics. We are therefore in this branch of biology more exclusively dependent on the evidence afforded by the distribution of existing forms.

If we can trace a gradual development from the generalized to the more specialized forms only in passing from north to south, from the North Pole by the great circles of longitude—while if we pass by the circles of latitude round the world we find, until we come to the confines of the arctic zone, that the former are specifically unlike while the climatic conditions are the same—we have the locality of origin clearly indicated. The moment we reach the Arctic zone we are everywhere surrounded by the same species. But if we follow the continental masses of the New World to the South Pole, thence returning up a meridian which crosses Africa and Europe, or Australia and Asia, we shall find in the descent abundant fossil evidence that we are moving onwards by the path along which the prehistoric migrations of the animal-world proceeded, and on our return we shall find that we are moving counter to their obvious movement.

Round the shores of the Arctic Sea the same fauna and flora are found in every meridian. As we pass southward along the three principal lines of land towards the Cape, Tasmania, and Tierra del Fuego, specific identity gives place to mere identity of genera ; these are replaced by family resemblances, and at last even the families become in a great measure distinct, not only on the great continents, but also on the islands, till every little rock in the Southern Ocean has its peculiar inhabitants. Thus the living faunas of Patagonia,

New Zealand, and South Africa are separated by infinitely wider divergences than those of any more northern regions; therefore these southern continents must have been more or less completely isolated during long periods, both from the northern continent and from each other. It would appear that, north of the equator at least, animals slowly migrated southward, keeping pace, as it were, with the growth and southward extension of the grand land-masses which appeared above the sea as the globe cooled. I have alluded to the identity of forms round the Polar area. We have, for instance, two peculiar forms of the *Laridæ*—*Pagophila* and *Rhodostethia*—girdling the Arctic circle; so, too, the Turnstone, perhaps the most widely distributed of birds, and many species of *Tringæ*.

But when we come further south we find, along with a steadily increasing divergence, cases of closely allied species recurring at intervals widely apart. Both these facts seem in perfect harmony with the hypothesis of three grand principal lines of migration—Western Europe, Eastern Asia, and Eastern America.

Take as an example the Woodpecker tribe. Here we have the genus *Picoides* confined almost exclusively to the most northern habitats of forest trees. We find one species, with varieties barely, if at all, separable, from Norway eastward to the Rocky Mountains, and others, very closely allied, across the northern belt of America. The next most northerly form of Woodpecker is represented by our *Picus major*. Of this group, the typical *Picus*, there may be from fifty to eighty species, according to the differing views taken by systematists. But whether we look to the European, Asiatic, or American forms, we find a close similarity in the most northerly species; while as we proceed southward the species become more and more distinct, until, before entering the tropics, we have lost the genus altogether. *Picus major* is identical in Britain and Japan; the North-American *P. pubescens* and *P. harrisi* of the west of the Rocky Mountains are not far separate. From each we find further and further divergences till we come to Formosa, Algeria, and

Texas. When on the verge of the tropics we seem to lose the genus.

The next most northerly groups of Woodpeckers are the genus *Gecinus* on the European and East-Asiatic lines of migration, and the genus *Colaptes* on the American line. These groups seem to have left the north before the *Picinæ*, and to have pushed further southwards. They vary still more from the original type in their southerly migration, especially when they penetrate into the Indian region, as in such species as *Gecinus mentalis* and *G. puniceus*. In the case of *Colaptes* we have the instance of *C. chilensis*, the most divergent and the least differentiated of the group, as if the direct descendant of progenitors who, at a very early period, pushed southward till they reached a climate similar to that of their original home, and thus never became differentiated like those which remained in warmer latitudes. Both *Picus* and *Gecinus* reached the southern shores of the Mediterranean, but never crossed the Saharan Ocean.

All the other families of Woodpeckers, driven southward long before the above-named had left the north, have become more and more segregated, and can at once be classified into the three great groups which have peopled the Indian, Ethiopian, and Neotropical regions. Why not one of them ever crossed the mysterious dividing-line between Bali and Lombok is a problem only to be solved when research shall have revealed to us more accurate knowledge of the conformation of the Indian and Australian areas during the Miocene epoch.

The similarity of the fauna of Japan with that of Western Europe has often been noted, and also the remarkable fact of forms occurring in Japan which do not recur till we reach the west of Europe, while there is no affinity with the avifauna of America. Take as an instance *Cyanopica*. If the Azure-winged Magpie had been wholly or partially circum-polar, we could easily understand one party going down Western Europe and halting in Spain, the other resting in Japan. Of *Pica*, colonies seem to have started down the routes of Europe and East Asia, and a third down the west side of the Rocky Mountains, while some selected the North-



American route. Being a genus unfitted for great heat, it penetrated no further than Algeria, California, and North China, retaining an identity all but specific everywhere, except in the southern limits of its migration to Algeria and California, where the species are markedly distinct.

Of the Jays, *Perisoreus* remains in the Arctic regions, with very slight variations. *Garrulus*, which left earlier, has varied more rapidly as it worked southwards and, like many other families, has never even crossed the Sahara.

I assume that the progenitors of the tropical forms naturally left the north long before those better adapted to endure change of temperature, and thus had an infinitely longer period in which to become more and more differentiated.

I do not pretend to explain how it happens that great families are now restricted to particular regions, while other regions not less fitted, so far as we can judge, for their maintenance are without them: how, for instance, the Humming-birds, the Toucans, the Tanagers, are solely Neotropical; the Plantain-eaters and the Guinea Fowls solely Ethiopian; the Pheasants solely Indian; the Honey-suckers only Indian and Australian; the Sun-birds only Indian and Ethiopian. But the Polar theory seems to give the only possible solution, viz. that their respective ancestors left by one or two routes only, or that the other parties perished early in the struggle for existence. Now the only marked exception to the close similarity—I had almost said identity—of the North-American land-bird fauna with that of the Old World is in one peculiar family, the American Warblers, or *Mniotiltidæ*. Structurally these differ very widely from our Warblers; but they are all migrants, visiting North America only in summer, and we cannot look on them as northern forms at all. They are simply Neotropicals, which have no representatives in other regions, and which have preserved their old traditions of hugging the north as closely as they could, though greatly modified in structure. The hereditary instinct in them has been more permanent than the form. There is also another possible cause, viz. that the North-American continent has been in various parts repeopled from the south after its

central mass,—which during the Miocene period was a vast shallow sea-basin, thus quite interrupting any retrocession of the great previous immigration into South America in the Triassic age,—had been upraised and become a vast table-land drained by the feeders of the Mississippi.

I propose to defer to another paper a more detailed consideration of the mode of distribution of many other families, such as the Thrushes, and of the insular avifauna, and especially of the limits and operation of the glacial epoch, premising that I am not prepared to invent glacial epochs as an easy solution of difficulties. I will now only add—what I hope to work out more fully hereafter—that in the Polar origin of life we seem to have a key to that perplexing riddle, the migration of birds.

All ornithologists are aware of the instincts, strong in all species of birds, without exception, which attract them to the place of their nativity. When increasing cold drove the mammals southward, they could not retrace their steps, because the increasing Polar sea, as the Arctic continent sank, barred their way. The birds reluctantly left their homes as winter came on, and followed the supply of food. But as the season in their new residences became hotter in summer, they instinctively returned to their birthplaces and there reared their young, retiring with them when the recurring winter impelled them to seek a milder climate. Those species which, unfitted for a greater amount of heat by their more protracted sojourn in the northern regions, persisted in revisiting their ancestral homes, or getting as near to them as they could, retained a capacity for enjoying a temperate climate, which would gradually be lost by the species which settled down more permanently in their new quarters; and thus a law of migration became established on the one side, and sedentary habits on the other.